Multi-vertex fiTQun for pion scattering measurements in WCTE
Adding constraints

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multi-ring tuning strategy

- Using muon rings to have an easy to distinguish number of rings,
- First muon at the beam pipe,
- Second muon starting position following exponential distribution along the beam direction (using an interaction length of 40 cm) and inside a diameter of 5 cm in the transversal plane,
- Second muon direction will be based on pion scattering angle.

# New display, rings better visible thanks to Sahar
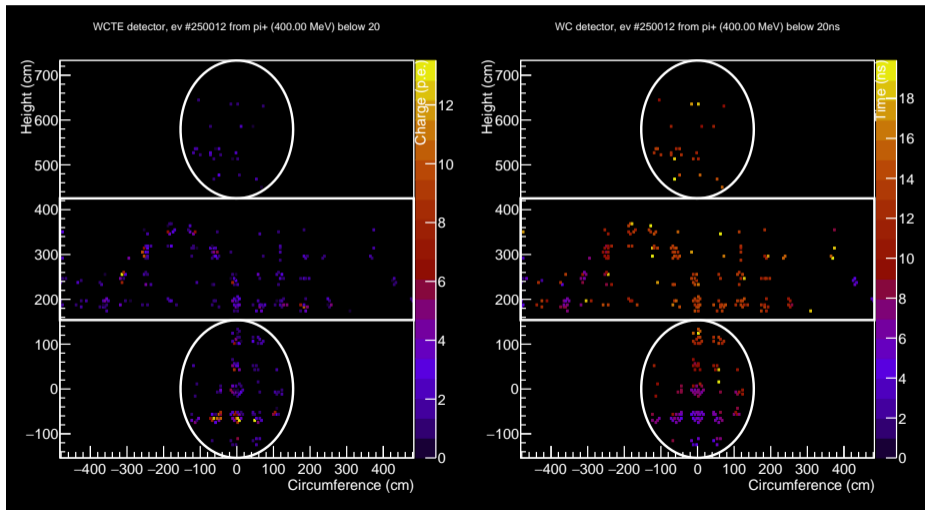
Track display, lack of pion elastic scattering

- Pion elastic scattering not saved in WCSim tracks,
- Following the *hloni* electron, we can deduce the true pion trajectory.
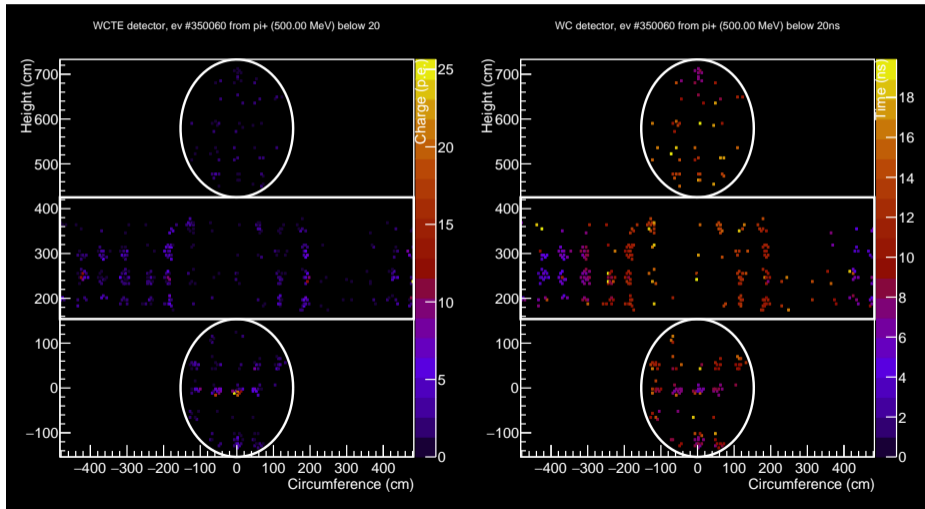

WC detector, ev #250012 from pi+ (400.00 MeV)

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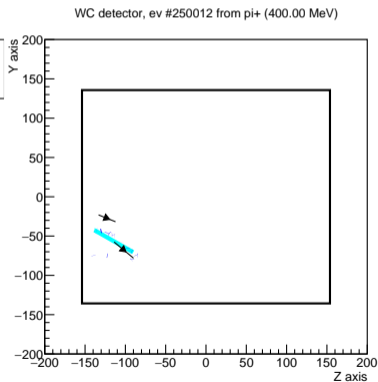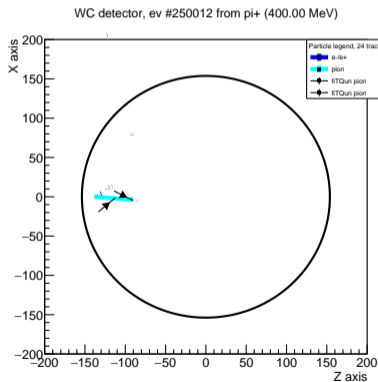
Looking at the residual time for better image of each ring

- $T_{res}^i \equiv t_i - t - |R_{PMT}^i - x|/c_n$ is the residual hit time calculated on the assumption of a point-like light source and subtracting the photon time of flight

- Is it only for vertex prefit?

WC detector, ev #350060 from pi+ (500.00 MeV)

WC detector, ev #350060 from pi+ (500.00 MeV)
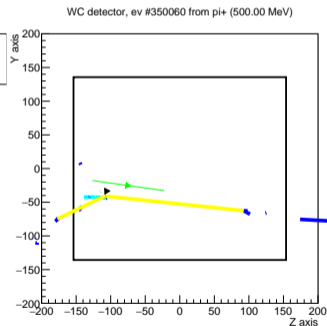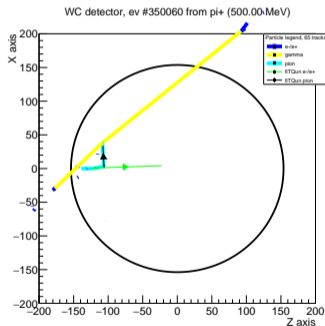
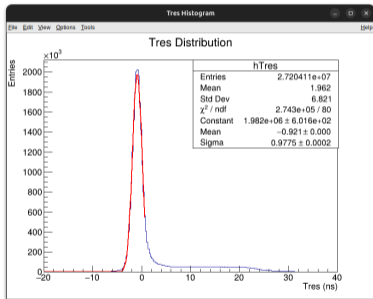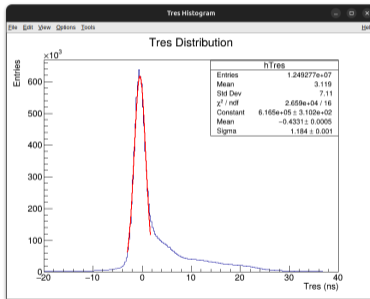# With the Residual time based on SK (-30 ns to 60 ns)

Residual time in WCTE

Figure: 1 muon

Figure: 2 muons, 1m away

Figure: 1 pion

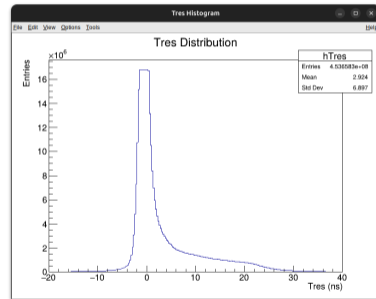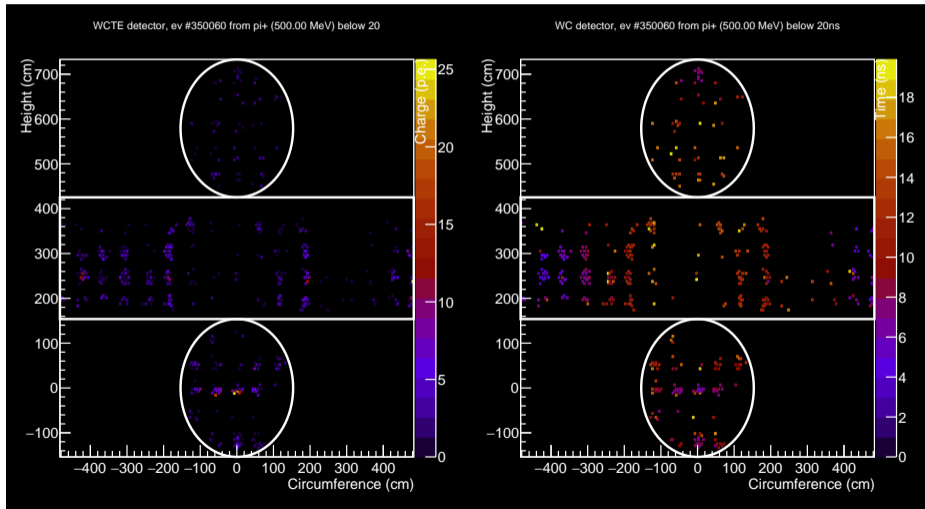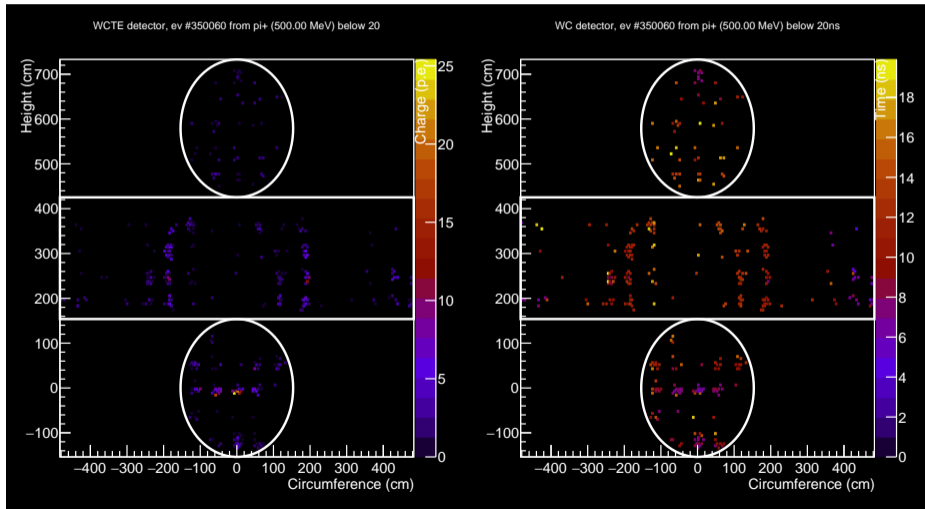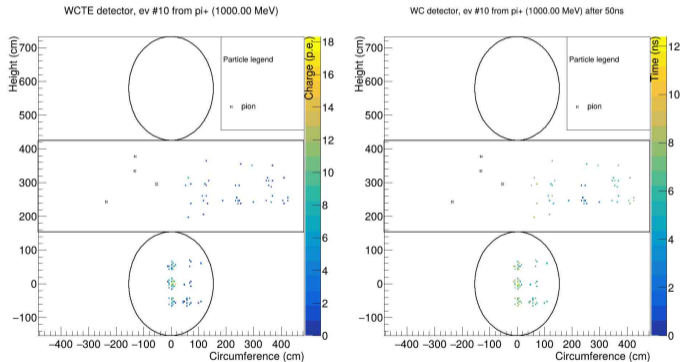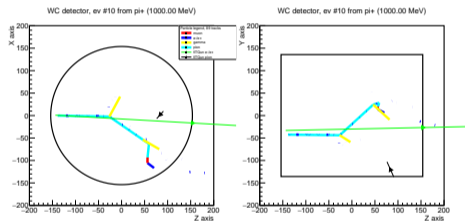## With the Residual time (-10 ns to 20 ns)

With the Residual time (-5 ns to 10 ns)

Track display, only few PMT hits below 9 ns

Conclusion

- I added constraints on fiTQun first track (position for now), seems to work, needs more statistics,
- It will be ideal to have the pion elastic scattering to WCSim output,
- We should make a list of what is missing or not working well in WCSIM and contact Ka Ming Tsui,
- Changing the threshold for residual time in fiTQun could help better reconstruction?
- I am redoing the MR tuning with Multi-Vertex (new threshold found for 1/2 rings), with exponential distribution for second muon position.